A REINTERPRETATION OF THE ARENIG CRINOID *RAMSEYOCRINUS*

by JOHN C. W. COPE

ABSTRACT. A new specimen of the early Arenig inadunate crinoid *Ramseyocrinus* shows unequivocally that the genus had a cup composed of four basal and five radial plates, the latter supporting five arms. There are no anal plates in the dorsal cup. The separate familial status of the genus is confirmed and emended diagnoses of the family, and genus, and a revised description of the species *R. cambriensis* are given.

RAMSEYOCRINUS was proposed by Bates (1968) for *Dendrocrinus cambriensis* Hicks from the early Arenig of Ramsey Island, south-west Dyfed. Bates' description of material in the National Museum of Wales allowed him to clarify certain aspects of the morphology of this early crinoid and established several features which Ramsbottom's earlier description (1961) had not specified. Thus, Bates demonstrated that *Ramseyocrinus* had a four-lobed stem and suggested that the dorsal cup was composed of probably three basal and four radial plates together with an infer-radianal at the dorsal end of the anal sac.

Donovan (1984) showed that the four-lobed stem of *Ramseyocrinus* was tetrameric proximally and suggested, contrary to Bates' interpretation, that three radial plates supported four fixed brachials and an anal plate. Donovan considered that basal plates were absent or hidden by the stem attachment and on the basis of the unique plating he proposed a new family, the Ramseyocrinidae, for the genus (Donovan 1984).

Recent work in the Carmarthen area has yielded a single specimen of *Ramseyocrinus* from the Bolahaul Member of the Ogof Hên Formation in the Roman Road section, Carmarthen, first described by Murchison (1839) and recently revised by Fortey and Owens (1978).

The horizon is the same as that from which the holotype was obtained on Ramsey Island some 70 km to the west and the associated fauna is similar. The Carmarthen *Ramseyocrinus* is, however, the best preserved specimen of the species yet available and shows clearly that:

(i) above the stem is a circlet of four plates (basals of Bates 1968, radials of Donovan 1984);
(ii) above these four plates is a circlet of five equal plates each of which supports an arm (see text-fig. 1);
(iii) there is no anal sac arising from the dorsal cup.

This interpretation is clearly at variance with those previously produced and in an attempt to clarify the morphology of the species, all the existing material in the National Museum of Wales, the British Museum Natural History, and Manchester Museum was re-examined. The conclusions were that:

(i) the Carmarthen specimen was certainly conspecific with *R. cambriensis*;
(ii) there was no morphological discrepancy between the specimens which could not be explained in the light of the new specimen;
(iii) that this new specimen showed that *R. cambriensis* shared many characters with *R. vizcainoi* Ubaghs from the Arenig of the Montagne Noire (Languedoc, France).

The first apparent disparity which had to be resolved was the anal tube, reported first by Bates in specimen NMW 29.308G.296 (Bates 1968, pl. 76, fig. 2). In this figure the 'anal tube' projects out towards the reader. Comparisons with the Carmarthen specimen would require this 'anal tube' to be an arm and the original specimen from which Bates' latex cast was made was restudied. Upon

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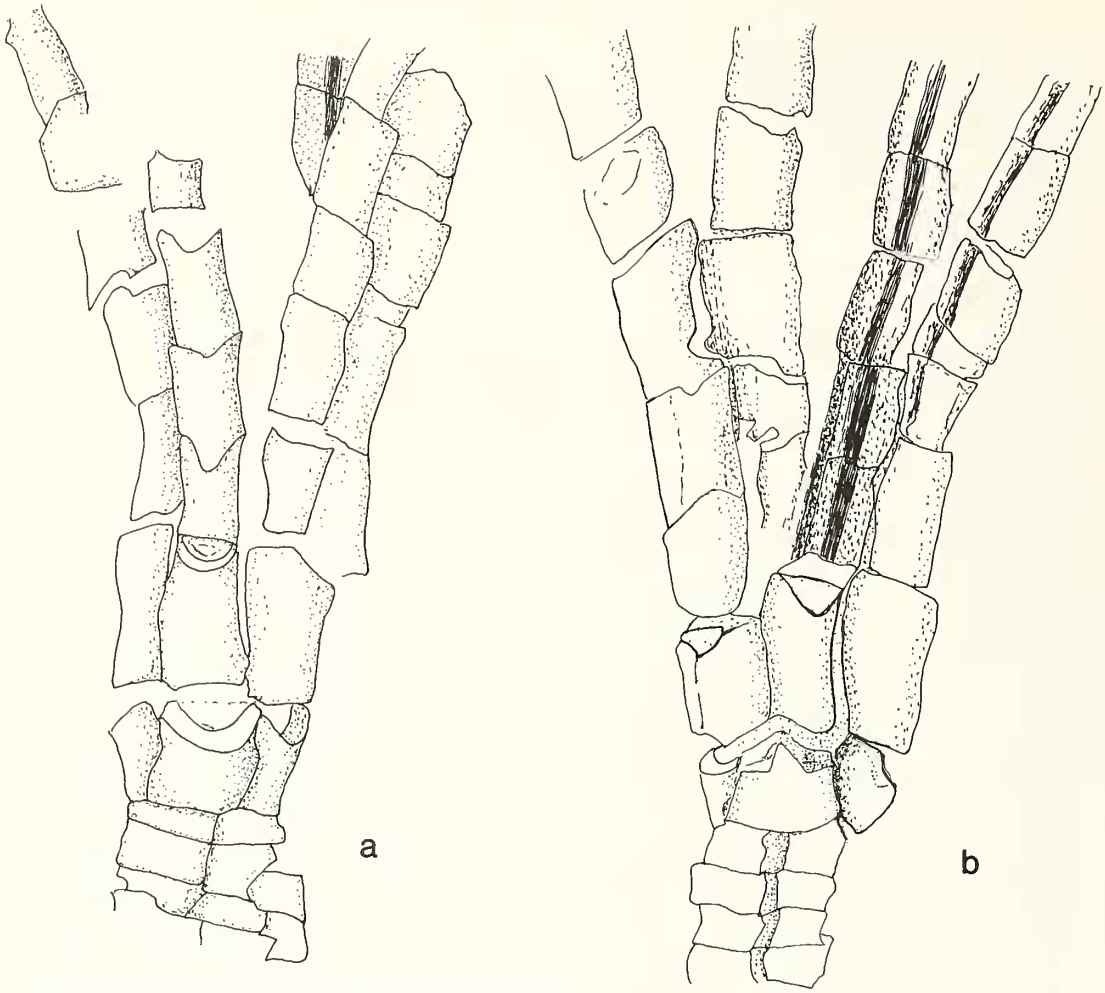
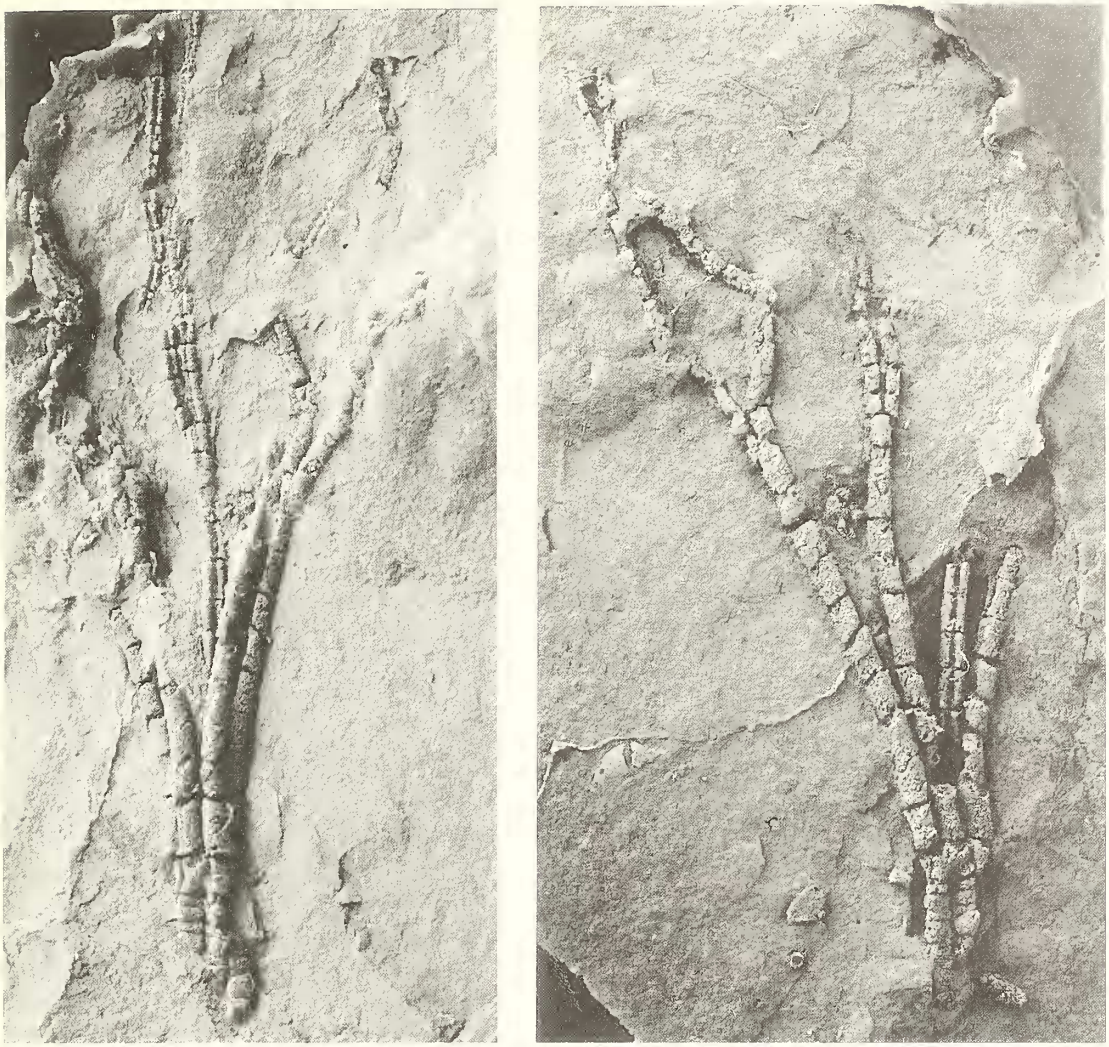


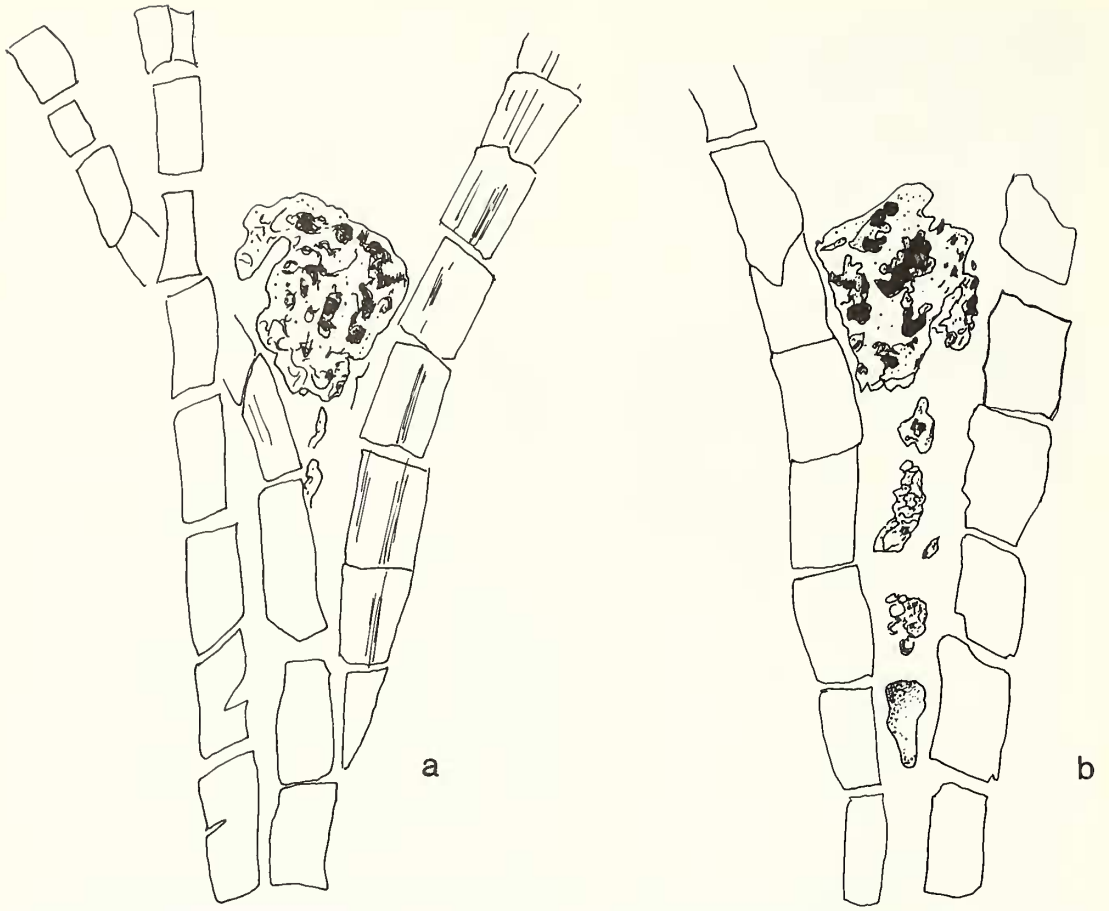
TEXT-FIG. 1. Camera lucida drawings of the dorsal cup and lower brachial plates of latex moulds of *Ramseyocrinus cambriensis*. Carpenter ray notation based on anus being as in text-fig. 3. *a*, NMW 86.93G.1*a* showing, from left to right B, A, and E radials. The arm showing food grooves is in the C ray. *b*, NMW 86.93G.1*b* showing, from left to right, D, C, and B radials. Note that radial D, supported by two basals, is shorter than the other radial plates. The arms showing food grooves are in the B and A rays.

examination it is apparent that the 'anal tube' disappears into the matrix and the length of the 'tube' corresponds to the depth to which the latex has penetrated the mould and does not reflect the true length of the appendage. In order to ascertain the nature of this appendage the reverse of the specimen was excavated initially in the hope of exposing either a fifth arm or an anal tube. In the event the specimen proved to be so compressed that when the shale thickness had been reduced to 3 mm or so there was real danger of damage to the specimen. At this stage the specimen was X-rayed by means of a Faxitron X-ray imager and the resulting print showed a Y-shaped structure, clearly a branching arm. There is thus no longer any discrepancy between the morphology of that specimen and the Carmarthen specimen concerning the anal tube. The fourth basal plate of the Carmarthen specimen can be explained by loss of an inter-basal sutural ridge on the limonitic mould of Bates' specimen through damage.



TEXT-FIG. 2. Photographs of latex moulds of *Ramseyocrinus cambriensis* from the Bolahaul Member, Ogof Hên Formation, Roman Road Section, Pensarn, Carmarthen, South Wales. *a*, crown NMW 86.93G.1*a* showing arms, from left to right, B; A (branching and with food grooves); adoral view of C; E, crossing over D to form branches with food grooves at extreme right of figure; and D, branching with food grooves. Note circular cluster of plates between C and D arms at level of 1Br8 plates. × 5. *b*, crown of counterpart, NMW 86.93G.1*b*. Food grooves are seen in the B and A rays and the arms in D and C rays are seen to branch. Note plate between arms D and C at level of 1Br4 plates, and cluster of plates between these arms at level of 1Br8 plates. × 5.

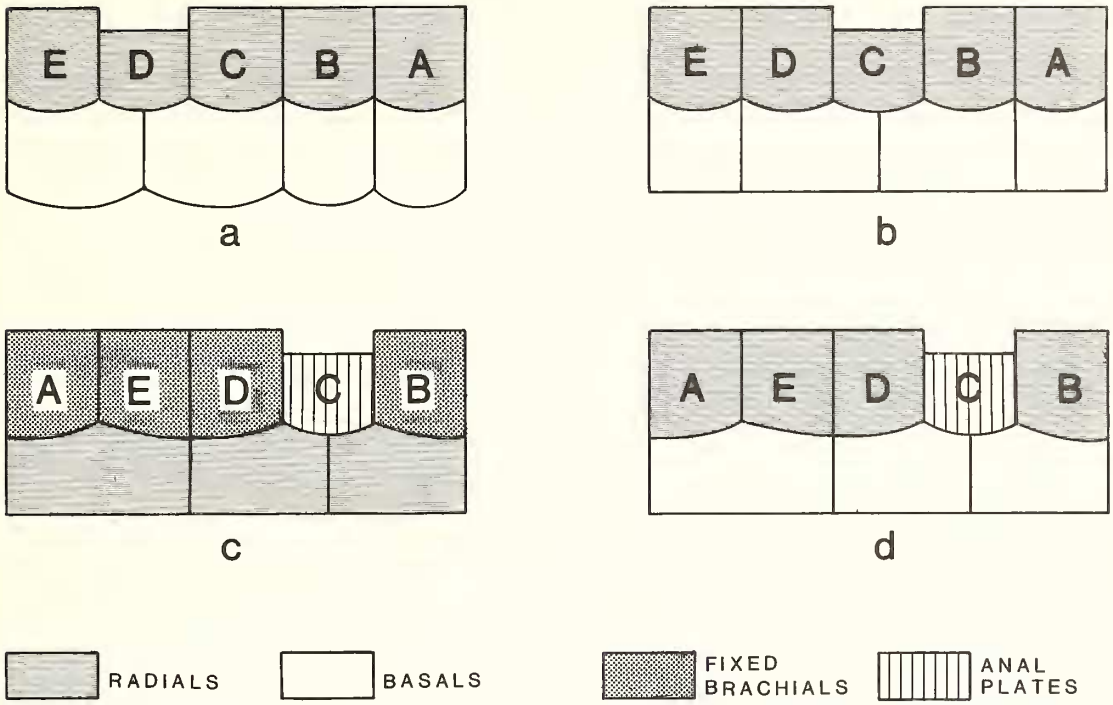
Another fine example of *Ramseyocrinus* is housed in the collections of Manchester Museum (L.12360). This specimen shows five appendages, one of which was interpreted by Donovan (1984, p. 624) as the anal tube. Again in this specimen the 'anal tube' disappears into the matrix. In this case it has not been possible to develop the specimen far enough with safety to see if this appendage is branched and therefore an arm, but the rest of the features are identical to the Carmarthen specimen and to Bates' material, so that a similar organization can be safely assumed.



TEXT-FIG. 3. Camera lucida drawings taken from the specimens of the auxiliary plates visible between two arms, here interpreted as anal plates. *a*, NMW 86.93G.1*a*. *b*, NMW 86.93G.1*b*.

Orientation of the cup

Having shown that the 'anal tube' of *Ramseyocrinus* is a fifth arm, there is now some doubt over the orientation of the cup. However, the Carmarthen specimen does show a mass of very small plates between two arms, apparently originating from a single large plate visible at the level of one of the fourth primibrachs. This series of plates is terminated distally by a roughly circular arrangement of plates at the level of the eighth primibrachs and can be seen in text-fig. 2 between two arms at that level (see also text-fig. 3). This series of plates could well be the anal series, as no anal plates appear in the dorsal cup and no other plates occur between any of the other arms. If one takes the interray containing these plates as the posterior interray (CD) then the plates can be identified as in text-fig. 4*a*. The number and size of plates bears a remarkable similarity to that obtaining in *R. vizcainoi* Ubaghs, 1983. Ubaghs (1983, text-figs. I and H) identified the smallest radial plate as supporting an anal sac, but admitted that this appendage could be a fifth arm (1983, p. 49). If one allows this, and redesignates the plates of Ubaghs' species, *R. vizcainoi* is seen to be virtually identical in plating of the dorsal cup to *R. cambriensis* (see text-fig. 4*b*). In his description of the former, Ubaghs (1983, p. 52) further comments on a mass of small irregular granules between the arms at the posterior of the crown; these could well correspond with the presumed anal plates of the Carmarthen specimen. The small plates figured by



TEXT-FIG. 4. Varying interpretations of the dorsal cup of *Ramseyocrinus*. *a*, *R. cambriensis* as interpreted herein; *b*, *R. vizcainoi* after Ubaghs 1983, text-fig. 11H; *c*, *R. cambriensis* after Donovan 1984, text-fig. 1C; *d*, *R. cambriensis* after Bates' 1968 description and Donovan 1984, text-fig. 1D.

Bates (1968, p. 76, fig. 2) remarked on by Ubaghs (1983, p. 52) are very much more widespread on the specimens (part and counterpart) than the figure implies and cannot be identified solely with the anal plates.

Plate homology

Ramsbottom (1961), Bates (1968), and Ubaghs (1983) termed the lowest visible plates of the dorsal cup basals, and the circlet above these the radials. In contrast, Donovan (1983) considered that, as the radials were directly supported by the basals in the earlier interpretations, the basals were radial in position and so could not be considered as other than themselves radial plates, as they were the lowest plates of the cup directly in line with the arms. In his interpretation (1984, pp. 624–625) three radial plates supported four fixed brachial plates, the basal plates being absent or hidden beneath the stem attachment (text-fig. 4*c*).

A further interpretation was given by Moore *et al.* (1978, p. T554) who suggested that basal plates supported split radial plates (infer- and super-radials) in each ray. This reading interprets the lowest brachials as a fixed 'super-radial'. [Those unfamiliar with British stratigraphy should note that the species does not occur in the Tremadoc as recorded by Moore *et al.* (1978, p. T554) since the rocks from which it was described are in fact of Arenig age (Pringle 1930).]

The stem attachment is shown very clearly in the Carmarthen specimen and it appears unlikely that another circlet of plates lies beneath the lowest visible plates. In addition, as the anal tube in Donovan's interpretation is now shown to be an arm, the lowest plate in line with the arm in the D ray (labelled C by Donovan) must be a radial plate; the other four plates in this circlet must also therefore be radial plates, and the plates below are basals. In this interpretation the cup has four basal and five

radial plates. No brachial plates are fixed; the Carmarthen specimen shows clear articulation facets on the radial plates (text-fig. 1).

The suprageneric position of Ramseyocrinus

With its tetrameric stem, four basal plates, five radials, and five arms, *Ramseyocrinus* is unique. There is a plane of bilateral symmetry through the cup plating passing from the AB interray through the D ray. Of the various types of symmetry of inadunate crinoids figured by Ubaghs (1978, p. T62), *Ramseyocrinus* comes closest to the heterocrinid type, but does not have split radials. The symmetry pattern of *Ramseyocrinus* is considered to have arisen from the amalgamation of a tetrameric stem with the pentamerous symmetry of the arms, and is not considered a useful taxonomic pointer. It was because *Ramseyocrinus* was believed to have four arms and an anal tube that the genus was included in the family Eustenocrinidae by Moore *et al.* (1978). However, Donovan (1984, pp. 624 and 626) listed the ways in which *Ramseyocrinus* differed from eustenocrinid genera, including the fact that all the latter have compound radials, various different arrangements of the anal plates, and different stems. He concluded that the *Ramseyocrinus* was so different from the eustenocrinids that he erected a new family, the Ramseyocrinidae to accommodate it.

Since the morphology of *Ramseyocrinus* is now known in more detail, a revised diagnosis of the family and only known genus is required.

Class CRINOIDEA J. S. Miller, 1821
Subclass INADUNATA Wachsmuth and Springer, 1881
Order DISPARIDA Moore and Laudon, 1943
Family RAMSEYOCRINIDAE Donovan, 1984

Emended diagnosis. Monocyclic inadunate crinoids with cylindrical cup as wide as proximal column. Cup symmetrical in AB–D plane. Four basal plates supporting five radial plates; anal plates not present in dorsal cup. Five arms. Proximal stem quadripartite; distal stem holomeric, tetragonal.

Genus RAMSEYOCRINUS Bates, 1968

Type species (by original designation). *Dendrocrinus cambriensis* Hicks 1873.

Diagnosis. As for family Ramseyocrinidae.

Ramseyocrinus cambriensis (Hicks 1873)

Text-fig. 2

1873 *Dendrocrinus cambriensis* Hicks, p. 51, pl. 4, figs. 17–20.
1960 *Iocrinus? cambriensis* (Hicks) Ramsbottom, pp. 5–6, pl. 3, figs. 9–11.
1968 *Ramseyocrinus cambriensis* (Hicks) Bates, pp. 406–409, pl. 76, figs. 1–5.
1984 *Ramseyocrinus cambriensis* (Hicks) Donovan, pp. 627–629, text-fig. 3.

Material, horizon, and localities. The addition to the specimens listed by Donovan (1984, p. 627) is NMW 86.93G.1*a* and 1*b* (part and counterpart) from the Bolahaul Member of the Ogof Hên Formation, Moridunian Stage of the Arenig (Fortey and Owens 1987) at the Roman Road, Pensarn, Carmarthen (GR.SN 41361915).

Description. The description by Donovan (1984, p. 627) is very full and the new specimen adds nothing to his description of stem and arm structure. The cup consists of four basal plates and five radial plates. The sutures between the four basal plates are each located over one of the lobes of the tetrameric stem and the lower plate sutures follow closely the upper margin of the stem. It appears unlikely that there are further plates of the dorsal cup hidden at this point. The basal plates are of two sizes; small basals are present in the A and B rays and are joined respectively to two large basals which occupy the E and half of D ray, and C and half of D ray. The radial plates in the A, B, C, and E rays are equal in size, that of the D ray is shorter and, unlike the other radial plates, is supported by two basals. The arms are not seen in their entirety in the Carmarthen specimen. All the brachial plates are free. The number of primibrachs is estimated at nine or ten; in the A ray there are at least eight visible and in the B ray six are visible. Arms in all rays have some preserved secundibrachs; there are at least fifteen of

these in ray D. No tertibrachs or further brachial subdivisions are seen in the Carmarthen specimen, although Donovan (1984, p. 627) recorded pentibrachs. Food grooves are well defined in the arms (see text-fig. 2). Between the C and D rays is a series of plates interpreted as the anal series. The lowest plate of this group visible is at the level of the 1Br4 plate between the C and D arms (see text-figs. 2 and 3); this plate is succeeded by a mass of small granular material, clearly visible on the shale of the specimen but less apparent on latex casts. Adorally this granular area is terminated by a roughly circular arrangement of some seven or eight larger platelets (text-figs. 2 and 3).

Discussion. R. cambriensis is similar in many respects to *R. vizcainoi* Ubaghs from the Arenig of the Montagne Noire, which has a similar arrangement of four basal and five radial plates, one of which is shorter than the others (this assumes that the fifth appendage is an arm, not an anal tube). There are slight differences in the proportion of the plates, those of the dorsal cup are, in the French species, somewhat taller. The short radial plate here interpreted as in ray D is only marginally shorter in the French specimen. The plating of the arms differs too with only six to seven primibrachs and seven or eight secundibrachs in the French species. Clearly the two species are closely related.

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